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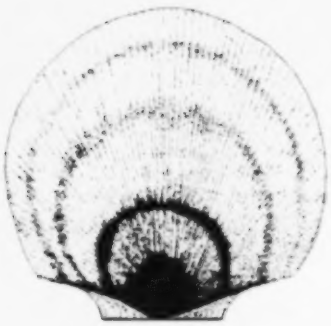
Maritimes Region
Canadian Science Advisory Secretariat
Science Advisory Report 2010/036

ASSESSMENT OF GEORGES BANK SCALLOPS (*PLACOPECTEN MAGELLANICUS*)



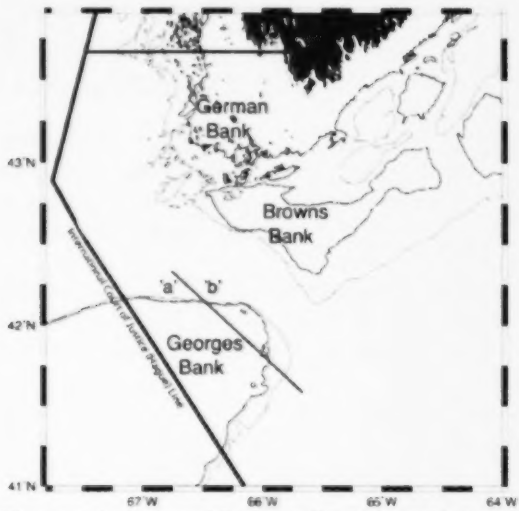


Figure 1. Location of Georges Bank 'a' and 'b'.

Context:

The sea scallop, Placopecten magellanicus, is found only in the Northwest Atlantic, from Cape Hatteras to Labrador. Scallops are aggregated in patches and harvestable concentrations are called beds. Major areas of offshore fishing activity are Georges Bank, Browns Bank, German Bank, the Eastern Scotian Shelf (Banquereau, Middle Bank, Sable and Western banks), and St. Pierre Bank (south of Newfoundland). Scallops prefer a sandy, gravel bottom and occur in depths of 35 to 120 m on the offshore banks.

The offshore scallop fleet consists of wet fish vessels and freezer-trawlers. Generally, these vessels simultaneously fish two New Bedford offshore rakes, 4 to 6.1 m width, one on each side of the vessel.

Annual assessments of the status of the offshore scallop resource take into account the annual survey findings, meat size distribution in the catch, and fishery performance. The management of the main scallop fishery on Georges Bank refers to zone 'a'. Georges Bank zone 'b' is a marginal growth area for scallops and has separate management measures. The assessment and advice presented in this document use the assessment framework established in 2009 and are for Georges Bank zone 'a' only; some elements of the fishery in zone 'b' are also presented for historical purposes.

In support of management of the Georges Bank 2010 scallop fishery, a meeting of the Science Advisory Process was held 9 February 2010 at the Bedford Institute of Oceanography in Dartmouth, N.S., to: (1) assess the status of the resource; (2) provide harvest advice for the 2010 fishery; and (3) document by-catch in the fishery. Participants included DFO scientists, fishery managers, representatives of the industry and provincial government, and a non-governmental organization.

Canada

SUMMARY

- The 2009 total allowable catch (TAC) was 5,500 t[1] for zone 'a' and 350 t for zone 'b'. Total reported landings were 5,524 t for zone 'a' and 261 t for zone 'b'.
- The commercial catch rate did not change from 2008 to 2009 and remains above the long-term average.
- By-catch estimates of yellowtail flounder in 2009 were lower than in 2008; by-catch estimates of cod and haddock increased but are still below the 2006 and 2007 estimates.
- In 2009, survey catch rates of pre-recruit, recruit and fully recruited scallops were above their respective 28-year median levels. The 2009 estimate of recruits is higher than in any year in the survey series to date; however, the abundance of this year-class has declined from that observed as pre-recruits in 2008.
- Fully recruited biomass, estimated to be 18,320 t in 2009, declined from the 2008 estimate (20,760 t) but is above the 28-year median biomass of 10,405 t. Recruit biomass was estimated to be 19,640 t in 2009, the highest since 1981.
- The 2010 interim TAC of 5,500 t results in an exploitation rate of 0.15, and incoming recruitment is expected to be among the highest in the time series. Harvest scenarios ranging from 2,000 to 8,000 t are all predicted to yield increases in commercial biomass for 2010.
- Harvest scenarios depend on the successful recruitment of the large 2006 year-class to the fishery in 2010. They assume a natural mortality of 0.1 for the recruit biomass and no fishing mortality of scallops below 95 mm.

BACKGROUND

Rationale for Assessment

A meeting of the Science Advisory Process was held 9 February 2010 at the Bedford Institute of Oceanography (BIO), in Dartmouth, Nova Scotia to review the 2009 fishery and assess the status of the scallop stock on Georges Bank in support of the management of the 2010 fishery. Participants included DFO scientists, fishery managers, and representatives of the industry.

An assessment framework for Georges Bank scallops was reviewed at a framework meeting in February 2009 (Jonsen et al. 2009). Therefore, it was determined that the assessment approach would not be reviewed this year; only the assessment results and projections were reviewed.

ASSESSMENT

Fishery

The 2009 TAC was 5,500 t for zone 'a' and 350 t for zone 'b' (Table 1). Total reported landings were 5,524 t for zone 'a' and 261 t for zone 'b'. Based upon preliminary analysis of the 2009

[1] Throughout this report, 't' refers to tonnes of scallop meats.

fishery data and the annual stock survey data, an interim TAC of 5,500 t was set for the 2010 Georges Bank zone 'a' fishery and 200 t for zone 'b'. The commercial catch rate did not change from 2008 to 2009 and remains above the long-term average (Figure 2).

Table 1. Canadian landings of sea scallop meats from Georges Bank and total allowable catch (TAC), in metric tons. Since 1998, Georges Bank has been divided into zones 'a' and 'b'.

Year	Catch (t)	TAC (t)
1981	7612	--
1982	3918	--
1983	2418	--
1984	1945	--
1985	3812	--
1986	4900	4300
1987	6793	6850
1988	4336	5400
1989	4676	4700
1990	5218	5200
1991	5805	5800
1992	6151	6200
1993	6183	6200
1994	5003	5000
1995	1984	2000
1996	2996	3000
1997	4259	4250

Year	Catch (t)		TAC (t)	
	zone 'a'	zone 'b'	zone 'a'	zone 'b'
1998	3191	800	3200	800
1999	2503	1196	2500	1200
2000	6212	601	6200	600
2001	6480	395	6500	400
2002	6469	192	6500	200
2003	5985	199	6000	200
2004	3518	200	3500	200
2005	2484	201	2500	200
2006	3932	162	4000	200
2007	4000	401	4000	400
2008	5498	358	5500	400
2009	5524	261	5500	350

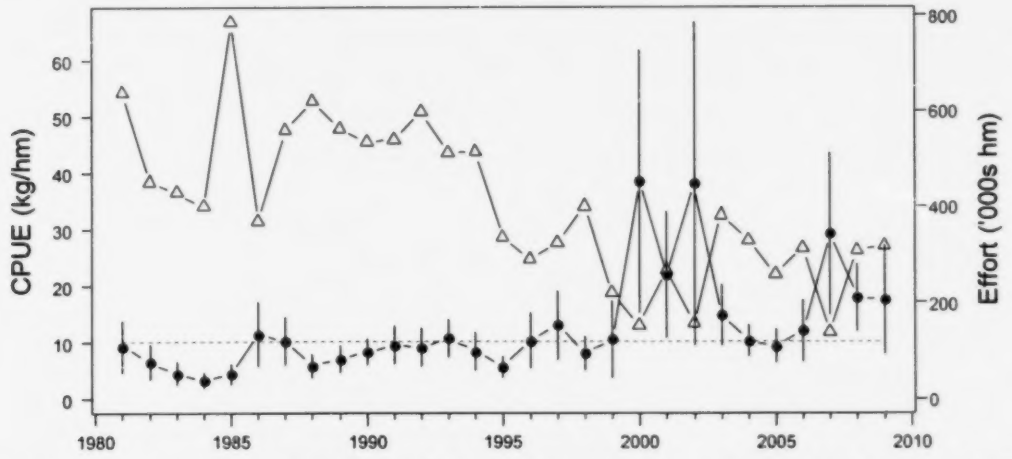


Figure 2. Annual catch per unit effort (CPUE, kg/hm, with jackknifed standard deviations) (•) and effort (hm) (Δ), wetfish and freezer trawler fleets combined, for Georges Bank 'a'. The dashed line is the 28-year median CPUE value.

By-catch

By-catch of yellowtail flounder, cod and haddock were estimated using the method described in Gavaris et al. (2009). Estimated discards of yellowtail flounder have declined sharply from 504 t in 2006 to 84 t in 2009, due to industry-implemented changes in fishing practices (Table 2). By-catch estimates of yellowtail flounder in 2009 were lower than in 2008. Estimated discards of cod increased from 36 t in 2008 to 69 t in 2009, and estimated discards of haddock increased from 33 t in 2008 to 54 t in 2009, but both cod and haddock discards are below their 2006 and 2007 estimates. Fishing effort during the 2006-2009 period has been relatively constant except for a sharp decline (>50%) in 2007. Effort increased slightly from 2008 to 32,556 hours (h) in 2009. The target for observer coverage is 2 trips per month. In 2009, this represented approximately 10% of the total hours fished.

Table 2. Estimated effort (h) and discards (t) of yellowtail flounder (ytf), cod, and haddock (had) caught as by-catch in the scallop fishery on Georges Bank 'a' and 'b' during the years 2006 – 2009.

Year	Observed Effort (h)	Total Effort (h)	Species	Total Estimated Discards (t)
2006	2027*	31,131*	ytf	**504**
			cod	**112**
			had	**62**
2007	1565*	14,394*	ytf	**96**
			cod	**114**
			had	**56**
2008	3325*	31,885*	ytf	**117**
			cod	**36**
			had	**33**
2009	3431	32,556	ytf	**84**
			cod	**69**
			had	**54**

*Updated to reflect changes in methodology (Gavaris et al. 2009)

Survey

Survey catch rates on Georges Bank 'a' for pre-recruits (<75 mm), recruits (75-94 mm) and fully recruited (≥95 mm) scallops were all above their respective 28-year median levels in 2009 (Figure 3). The large cohort (2006 year-class) observed in the 25 to 65 mm range in 2008 has grown to the 70 to 95 mm range in 2009 and now falls well within the recruit size range (Figure 4). The 2009 estimate of recruits is higher than in any year in the survey series to date (312 scallops/tow); however, the abundance of this year-class has declined from that observed as pre-recruits in 2008. Fully recruited scallops have declined from 2008 but remain above the long term median (Figure 3).

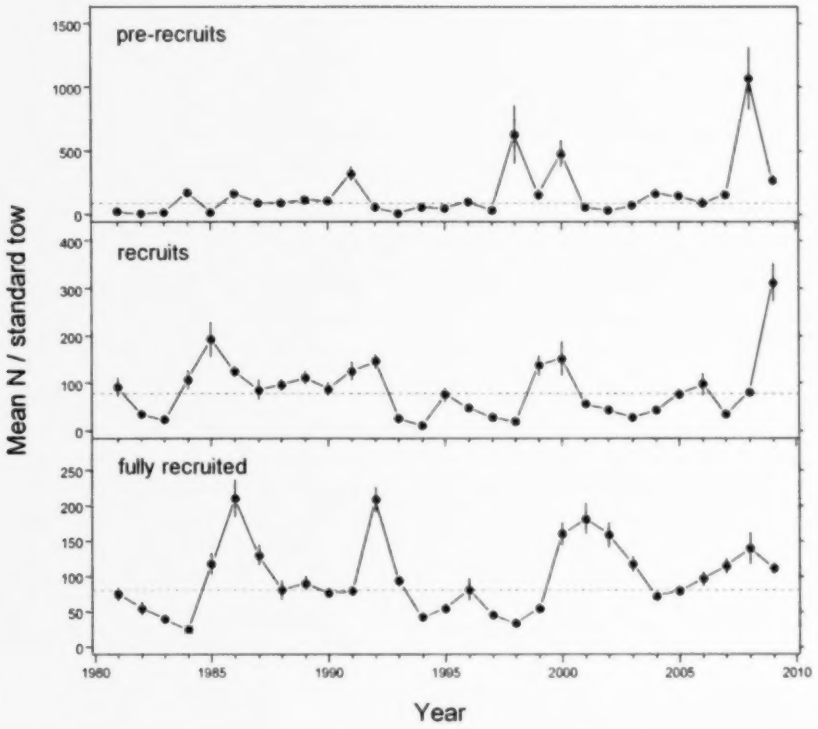


Figure 3. Survey abundance indices (mean number/standard tow) for pre-recruit (<75 mm since 1996, <60 mm from 1986-1995 and <45 mm before 1986), recruit (75-94 mm since 1996, 60-85 mm from 1986-1995 and 45-75 mm before 1986) and fully recruited (≥95 mm since 1996, ≥85 mm from 1986-1995 and ≥75 mm before 1986) scallops. The dashed lines are the 28-year median value for each size class.

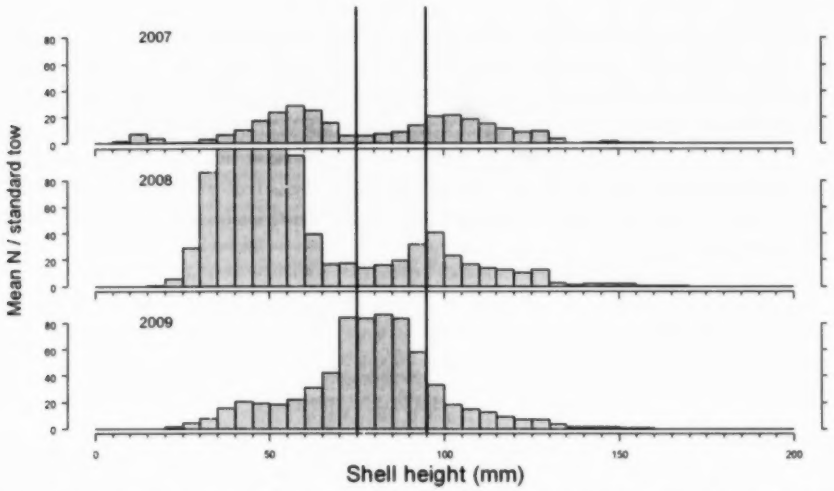


Figure 4. Mean number of scallops at shell height (mean number/standard tow) from the Georges Bank 'a' survey. The vertical lines indicate the divisions between pre-recruit, recruit and fully recruited size classes. The peak value in 2008 was 216 scallops per tow between 45-50 mm.

Population Model

The delay-difference model, described in Jonsen et al. (2009), was fit to the annual survey and commercial catch rate indices on Georges Bank 'a' to estimate commercial biomass and exploitation, as well as to provide 2010 biomass projections and harvest scenarios. Fully recruited biomass, estimated to be 18,320 t in 2009, declined from the 2008 estimate (20,760 t) but is above the 28-year median biomass of 10,405 t (Figure 5). Recruit biomass was estimated to be 19,640 t in 2009, the highest since 1981. The model's forecast for 2010 biomass is 32,615 t, assuming a catch of 5,500 t (the interim TAC). This represents an estimated 95% increase in biomass from 2009 (Table 3). Harvest scenarios ranging from 2,000 t to 8,000 t are all predicted to yield increases in commercial biomass with a very low probability of decline.

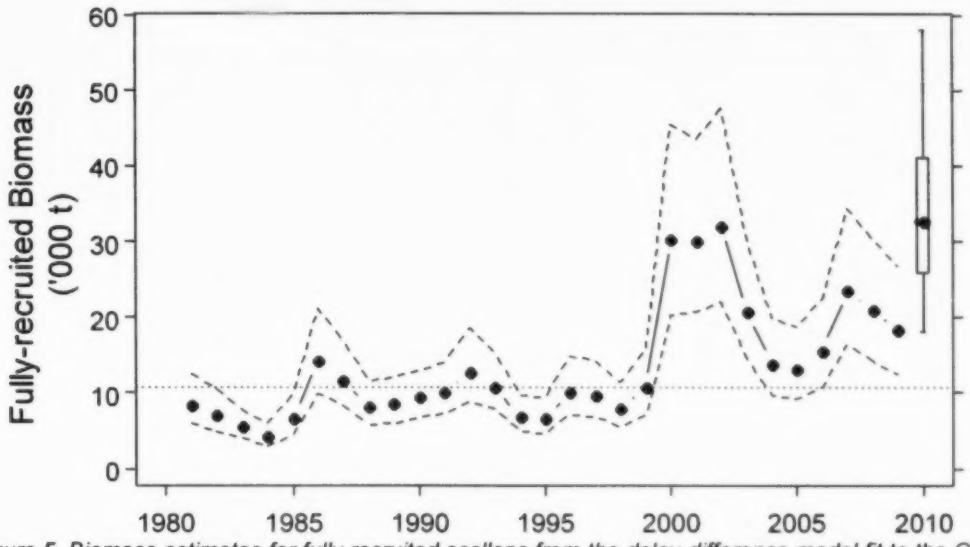


Figure 5. Biomass estimates for fully recruited scallops from the delay-difference model fit to the Georges Bank 'a' survey and commercial data. Dashed lines are the upper and lower 95% credible limits on the estimates and the dotted line represents the 29 year median. The forecasted fully recruited biomass for 2010, assuming a catch of 5,500 t, is displayed as a box plot with median(•), 50% credible limits (box) and 80% credible limits (whiskers).

Sources of Uncertainty

The delay-difference model assumes knife-edged recruitment and that natural mortality is 0.1 for both fully-recruited and recruit size classes. In effect, the model assumes that all scallops smaller than 95 mm shell height are not retained and there is no discard or incidental fishing mortality that results from fishing activity. The decline in the number of recruits and pre-recruits in 2009 from the number of pre-recruits in 2008 (Figure 3), as well as a higher proportions of clappers in high density areas, suggests that mortality of scallops smaller than 95 mm shell height is greater than 0.1.

There is spatial heterogeneity in the distribution of age groups. The fishing fleet targets particular scallop size classes that can result in spatial aggregation of fishing effort. This aggregation suggests that the commercial catch rate index may not be proportional to abundance or biomass. This non-proportionality could be exacerbated in the future with continued use of voluntary closure areas.

The delay-difference model tends to under predict biomass as biomass increases and over predict as it declines. This pattern is typical of many stock assessment models.

CONCLUSIONS AND ADVICE

Fully recruited (commercial) biomass has been above 10,000 t since 2000. This is due to a combination of two very large recruit cohorts in 1999 and 2000 (Figure 5), a shift by industry to generally lower exploitation rates, and the adoption of an industry-implemented protocol on a minimum landed scallop size from 1995 onward.

The 2010 interim TAC of 5,500 t results in an exploitation rate of 0.15, and incoming recruitment is expected to be among the highest in the time series. Harvest scenarios ranging from 2,000 to

8,000 t are all predicted to yield increases in commercial biomass for 2010 (Table 3). These scenarios depend on the successful recruitment of the large 2006 year-class to the fishery in 2010. They assume a natural mortality of 0.1 for the recruit biomass and no fishing mortality of scallops below 95 mm.

Table 3. Harvest scenarios for 2010 in terms of exploitation and expected changes in biomass. Potential catches in 2010 are evaluated in terms of the probability of a decline in biomass. These probabilities account for uncertainty in the biomass forecasts. In this year, all changes in biomass are predicted to be positive.

Catch (t)	Exploitation Rate	Probability of Biomass Decline	Expected Change in Biomass (%)
2000	0.06	0.05	100.60
3000	0.08	0.05	94.93
4000	0.11	0.07	90.22
5000	0.14	0.07	82.91
6000	0.17	0.09	75.85
7000	0.19	0.10	67.78
8000	0.22	0.12	61.42

SOURCES OF INFORMATION

Gavaris, S., J. Sameoto, A. Glass, and I. Jonsen. 2009. Discards of Atlantic Cod, Haddock, and Yellowtail Flounder from the 2008 Canadian Scallop Fishery on Georges Bank. TRAC Ref. Doc. 2009/06.

Jonsen, I.D., A. Glass, B. Hubley, and J. Sameoto. 2009. Georges Bank 'a' Scallop Framework Assessment: Data Inputs and Population Models. DFO Can. Sci. Advis. Sec. Res. Doc. 2009/034.

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